AC 2007-2826: USING STUDENT-LED CURRENT EVENTS DISCUSSIONS TO MEET SPECIFIC ABET OUTCOMES THROUGH ENGINEERING ECONOMY

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Using Student-led Current Events Discussions to Meet Specific ABET Outcomes through Engineering Economy

Introduction

While engineering departments tend to have many avenues for meeting ABET outcomes that are directly related to technical skills, it can be more challenging to find ways to address the outcomes related to "soft skills." At Union University, we have found that the standard engineering economy course provides an ideal atmosphere for delivering some of these broad-based goals. Specifically, we have been successful in using student-led discussions of current events related to engineering economics to directly address outcomes J (knowledge of contemporary issues) and I (recognition of the need for lifelong learning). These discussions also more obliquely address outcomes F (understanding of professional and ethical responsibility), G (ability to communicate effectively), and H (understanding of global and societal impact of engineering solutions).

This paper will describe how the current events discussions have been managed and how effective the resulting classroom interaction has been during the four years this technique has been formally used in the engineering economy course at Union University. It will also present specific student feedback, along with a three-step process for interfacing the engineering economy course to selected ABET outcomes.

Background and Goals

The engineering department at Union University was established in 2001 and earned ABET accreditation in 2006. As a new program, our classes are small; for example, engineering economy classes have had 2, 3, 4, and 6 students. One could argue that techniques used in such small classes cannot be successfully transferred to larger classes, but we believe they can and will provide suggestions for use by large classes in the section entitled "Limitations and Ideas for Future Development."

Since we have recently been through the accreditation process for the first time, we have had the opportunity to design a program from the ground up to meet the still relatively new Engineering Criteria 2000 (EC 2000). While no one suggests that the criteria are perfect, we have found that they do indeed allow flexibility to "focus on what is learned rather than what is taught," as ABET asserts in its organizational history.[1] The use of current events in the engineering economy course has been one of our direct attempts to encourage student learning, but we readily admit that using current events is not a particularly novel idea. In fact, others have introduced more formalized methods of integrating current events throughout the engineering economy course.[2] The main contribution of this paper is to demonstrate how this common-sense element of teaching engineering economy can be implemented, measured, and documented in a way that meets ABET requirements without placing a large administrative burden on the professor.

Description of Current Events Discussions

Three current events discussions are scheduled each semester, and they are listed on the syllabus and described on the first day of class. While the specific assignment in terms of content may vary among the three discussions, the general format is quite stable: Each student is asked to find an article written within the last three months that describes an engineering innovation previously unknown to the student, to identify specific engineering economy principles related to the innovation, and to provide a five-minute oral summary to the class. No written work is submitted. Grading has been handled in a slightly different manner each semester, but the current plan is to have each discussion contribute 1% of the overall course grade. This percentage seems to strike an appropriate balance between the relatively low effort involved in completing the assignment and the importance of teaching students to take responsibility for learning something beyond the textbook and outside of the classroom. A student's grade for each assignment is broadly recorded as an A (expectations fully met), C (a reasonable attempt was made to complete the assignment, but some element of the assignment was not appropriately executed), or F (absent or completely unprepared).

Various approaches to the specific content of the assignments, along with advantages and disadvantages, are listed below.

- Most commonly, the content of the article is completely unspecified, and students are free to choose from any area of engineering. Student interest tends to be higher when this approach is used, and the resulting classroom discussion is obviously more diverse and possibly more appealing – for the professor as well as students. However, it is also more challenging to connect the discussion to current classroom topics or to use it to highlight a specific principle of engineering economics.
- Students are sometimes instructed to find an article that explicitly discusses an economic aspect of the engineering innovation; other times, students are instructed to find an article that does not mention economics. If this approach is used, articles with an explicit mention of economics are assigned early in the semester (to make it easy for students to find necessary linkages between technical details and economic consequences), and articles that do not mention economics are assigned later in the semester (to test the ability of students to ascertain economic considerations on their own). Most students respond well to this progression, and it provides interesting insight into the maturity of their thought processes when they are required to autonomously determine relevant economic aspects of a project.
- Occasionally, the content of the article is restricted to a certain area related to some aspect of class, most commonly the class project. It is helpful for students to see how much diversity exists even within a restricted content area, and it is easier for the professor to manage the discussion in a way that promotes understanding of specific course material or assignments. However, student enthusiasm noticeably diminishes as content restrictions increase.
- Occasionally, students are instructed to find an article in a technical journal (in print) rather than on the internet. Along with many other institutions,[3,4] we have found that students automatically go to the internet as their first source for almost any assignment, and we want to encourage students to use the library and other sources of technical information.

Individual elements of the presentation format and their relationship to ABET outcomes are described below. Additional ABET tie-ins and information about assessment are included in the section entitled "Assessment and ABET Documentation." It is also important to note that we use the language of the outcomes when making the assignment to help students realize that they are engaging in lifelong learning … or gaining a broad perspective in a global context … or seeing an example of ethical responsibility … and so forth.

- The simple act of finding an article should at least hint at the importance of lifelong learning (outcome I), since even a cursory glance at the literature reveals the vast amount of existing information and the rapid pace of the addition of new information.
- The fact that students are required to find an engineering innovation previously unknown to them and to address related economic issues directly contributes to their knowledge of contemporary issues (outcome J). The requirement that it be previously unknown also helps to increase awareness of the importance of lifelong learning (outcome I). Depending upon the articles selected, especially if the discussion can be appropriately guided, this step may also provide students with an avenue for an improved understanding of professional and ethical responsibility (outcome F) and perhaps a small element of attaining "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context" (outcome H).[5]
- The identification of specific engineering economy principles more directly addresses the economic context mentioned in outcome H.
- The five-minute oral summary directly addresses one aspect of the students' ability to communicate effectively (outcome G), giving them practice not only in oral communication but also in delivering a concise summary of information that meets specified criteria in terms of length and content.

The assignment is straight-forward by design, and a few questions will naturally arise. First, one may wonder how we ensure that students actually find an innovation that is previously unknown to them. Since there is obviously no way to ascertain the students' previous knowledge, we use the honor system, and we have found that students generally respond quite well to the challenge. In some classes, a healthy competition – complete with great secrecy prior to the actual discussion – has developed among students seeking to find the most novel and unexpected innovations. We ask for a show of hands after every presentation to find out who has previously heard about the item being reported, and students are thrilled if they report on something that no one else has heard of. The discussions are generally quite fun!

Similarly, there might be questions concerning how we assure that other criteria for more specific assignments are satisfied. We basically use the honor system once again, although we often ask for the citation of an article that captures our interest, so students know that we will randomly read certain articles. As with the innovation factor described previously, students sometimes compete to find articles that catch our interest and take it as a compliment when we ask for a citation. In addition to these random checks, we have found that students take the assignment quite seriously when we consistently use the language of the ABET outcomes to introduce the discussions. There are some great phrases that represent worthy goals embedded in these outcomes, and the majority of students seem eager to work toward developing these habits

and understandings. So far, we have not found a situation where students do not follow the specified criteria for a given assignment.

Another question we have had concerning this assignment is whether it could be strengthened by including a written component. Students handed in a written summary the first semester we used current events discussions, but the assignment has been more effective at meeting our particular goals without it. We wanted to encourage students to spend time reading several articles and making an interesting selection rather than quickly selecting an article and spending time writing a report on it. Also, the time required on the professor's part to read and grade a written component is not appealing, especially as we fully expect our program to grow and therefore seek to establish ideas that can be used successfully in larger classes.

Finally, a major concern is whether having three discussions per semester takes too much valuable class time. Since our classes have been small, the discussions do not require the full class period. As we grow, we may employ some strategies listed in the section entitled "Limitations and Ideas for Future Improvement" to minimize the disruption of class time.

Assessment and ABET Documentation

There are two points of interest for professors regarding the effectiveness of any teaching technique. Obviously and most importantly, we must seek to assess how much the students have learned. However, if we teach in an accredited program, we must also find some way to "prove" or at least document that learning has taken place. The assertion that engineering economy students can learn from discussing current events is not controversial and thus will not be addressed in this paper. Instead, we will briefly outline how worthwhile the current events discussions are in terms of meeting certain ABET outcomes and how their usefulness can be adequately documented.

Feedback from students via course evaluations and informal conversations yields positive results in terms of actual student learning specifically related to the selected ABET outcomes being discussed in this paper. A couple of students have said that the engineering economy course does a better job of addressing the "soft skills" outcomes than any other course in the curriculum. Since the current events discussions are a major avenue for meeting these outcomes, these students' comments provide a direct and explicit endorsement of the method. Other comments have provided less explicit but equally valid evidence of learning, such as a comment from one student who began reading the *IEEE Spectrum* to find articles and fell in love with the journal! He expressed his intent to read it for the rest of his career, a clear allusion to life-long learning (outcome I) that was inspired by a simple article search in an engineering journal. Another student said that doing research for the current events helped him understand how engineering affects and improves society, providing support for our assertion that outcome H was addressed. After a discussion on various international power issues, yet another student expressed his desire to eventually return to his native country of Nigeria to help improve the power infrastructure there – a clear expression of intent to actually use his engineering education to make an impact in a global context (outcome H). Finally, at least half of the students said at the end of the course that 100% of the innovations described during class discussions were new to them, suggesting that their knowledge of contemporary issues (outcome J) was increased through the discussions.

(One could argue that they actually learned more about contemporary *events* rather than *issues*, but the events are at least a starting point toward understanding various issues. Also, we did discuss *economic issues* for every innovation.)

Based on these comments and many similar ones, we believe that learning specifically related to the ABET outcomes has indeed taken place. Our next task, then, is to find a way to document it. We have developed the three-step process outlined below.

- Students fill out a simple self-assessment tool (prepared by the departmental secretary) at the end of the course. The feedback sheet we use is shown in Figure 1 and contains a table of the educational outcomes originally listed on the syllabus for each course. Students are instructed to rate their personal attainment of each outcome on a scale of zero to four. This assessment is clearly subjective in nature, since it is based on the self-perceptions of students.
- The professor develops final exam questions to specifically test each of the course outcomes. The professor translates exam performance on the question or set of questions for a given outcome into a scale from zero to four to rate each student on every outcome that appears on the course syllabus. This process sounds time-consuming but actually does not add much time to the original grading task, especially after doing it once or twice. Sample questions are shown in Figure 2. This assessment is designed to be a quantitative faculty assessment based on a specially designed test.
- The departmental secretary runs a locally developed Excel macro to compare data from the previous two steps and to generate a report for each student and for the entire department. A strong correlation between the two sets of data suggests that student perceptions and quantitative reality are closely aligned, while a weak correlation or lack of correlation suggests the opposite. If the results of two different assessors (student and faculty) using two different methods (self-perception and testing) are closely aligned, this correlation suggests that program measurements are working reasonably well. If not, adjustments can be made to either help students have a more accurate perception or to improve departmental testing methods. A sample correlation chart is shown in Figure 3.

Note that the added burden on the professor is quite light, with direct involvement required only in the second step. Of course, a small amount of class time is required for the first step, although we have considered having the students fill out the self-assessment tool on-line to eliminate this disruption. Also, any changes suggested by the third step may require some of the professor's time over the long term, but implementation of these changes would be essential to overall program improvement and therefore should not be viewed as an added burden for this particular portion of the engineering economy course.

FEEDBACK SHEET

Course: EGR 330
Term: Fall 2006
Student Name:

EDUCATIONAL OUTCOMES	Code	I achieved the following outcomes as a result of this course. <--- fully ---------- not at all ---> 4	3	2	1	0
an ability to apply knowledge of math, science, and engineering	A					
an ability to function on multi-disciplinary teams	D					
an understanding of professional and ethical responsibility	F					
an ability to communicate effectively	G					
the broad education necessary to understand the impact of engineering solutions in global, economic, environment, and societal context	H					
a recognition of the ability to engage in life-long learning	I					
a knowledge of contemporary issues	J					

Figure 1. Self-assessment tool for students.
Note the simplicity! Also, note that outcomes A and D are included for completeness; they are covered in the course even though they are not discussed in this paper.

To test outcome G (an ability to communicate effectively):
(2 points) How did the current events discussions challenge you to develop your ability to communicate? Was it difficult to meet the 5-minute time restriction, and did it get easier to do so by the third discussion? Did you learn anything from observing the communication styles of other students?

To test outcome H (broad education to understand impact of engineering solutions):
(3 points) Name one innovation discussed in class and describe its impact specifically in one of the following contexts: global, economic, environmental, societal.

To test outcome J (knowledge of contemporary issues):
(2 points) Recall our three current events discussions. Approximately what percentage of the articles contained information that was new to you? (There is no right or wrong percentage; I am simply curious.) Which report did you find most interesting or surprising? Why?

Figure 2. Sample final exam questions.
Note that the questions are generally simple, open-ended, and worth 2 or 3 points per outcome. Their combined point value can make the difference of approximately a letter grade on the final exam, so students tend to take the questions seriously and provide worthwhile feedback. The remainder of the final exam contains traditional quantitative problems.

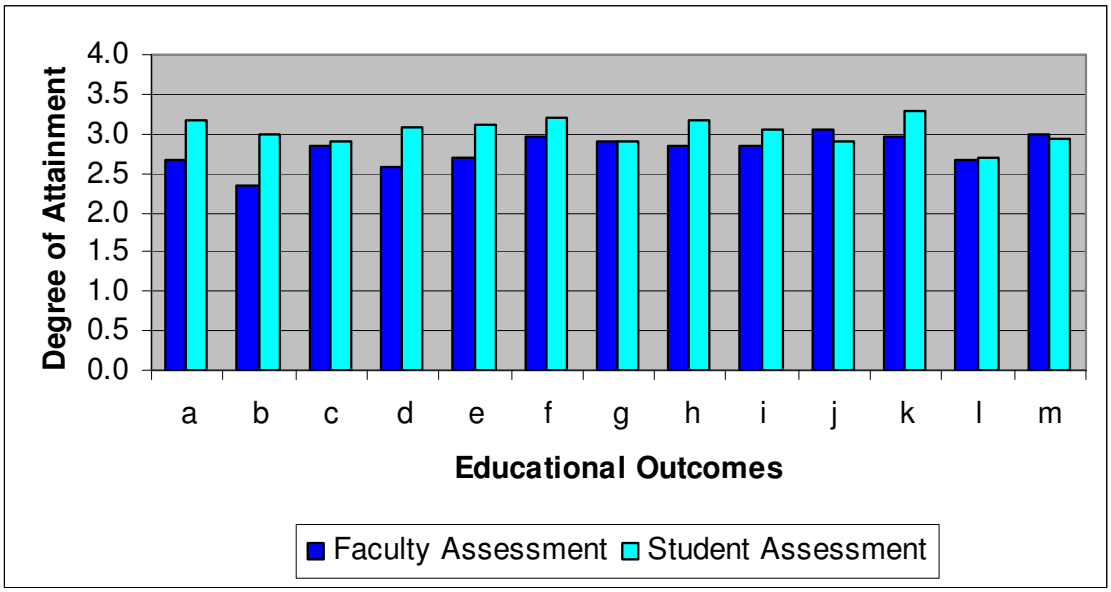

Figure 3. Sample comparison chart for the two assessment methods.
For each educational outcome, our goal is that the difference between the two sets of measurements should be smaller than the standard deviation of either data set.

Limitations and Ideas for Future Improvement

The biggest limitation of our method is that it has been tested only for small classes. The main difficulty introduced by a larger class is the logistical problem of finding time to allow everyone to participate in a meaningful way. For mid-size classes, the professor could divide the class into three groups and could join and moderate a different group during each of the current events discussions. The other two groups could be moderated by a graduate student or even self-moderated by the group. If a couple of graduate students are available, they could quickly be trained in applying the broad grading rubric – assigning an A, C, or F as described previously. If the group is self-moderated, the simple rubric could be explained to the entire class so that each student could apply the rubric to every other student, and the average could be taken to supply the overall grade. This system would allow the professor to hear from every student by the end of the third discussion; it would allow graduate students or the engineering economy students to think critically about what they are hearing from fellow students; and it would maintain the worthwhile elements of the current events discussions.

For large classes, a larger number of groups could be formed with the same possibilities of moderation by a graduate student or self-moderation; however, the professor would not have the advantage of hearing from each student at some point during the semester. Another possibility for large classes is to require students to give only one five-minute current events report rather than three, but this approach reduces the strength of our assertion that the discussions help students meet certain ABET outcomes and is therefore not preferred.

In looking ahead and planning for larger classes, we have sought to streamline the assignment and to minimize the amount of grading. Because the parameters of the assignment are clearly defined and easy to follow, students should not have many questions about its completion and thus student interaction related to this particular assignment should not grow tremendously with class size. In terms of grading, the immediate recording of a broad A, C, or F ensures that the professor will not get bogged down with grading current events discussions in addition to homework, exams, and so forth. It also allows for flexibility in terms of having a graduate student or the students themselves perform the grading task, as described above, with relatively little danger of introducing inequity into the grading scheme.

Another limitation is that the three steps described in the preceding section are part of a comprehensive ABET documentation strategy at Union University, and we use this three-step process throughout the curriculum to generate meaningful data for comparison in the third step. Some modification may be required to incorporate the method into documentation strategies at other universities, but many possibilities exist around the general framework of actively seeking connections to ABET outcomes and explicitly testing for their attainment. It is also very helpful to use the ABET language when making assignments to students so they will be involved in their own educational process and so they will recognize attainment when it has occurred.

Conclusion

We have developed a formalized method of using the standard engineering economy course at Union University to address selected ABET outcomes, most notably some of the outcomes that are widely considered to be among the more difficult to assess. Our first accreditation attempt using this method was successful. Although the current events discussions and assessment have been used only with small classes to date, we are hopeful that the method can be adapted to larger courses and other universities. We are seeing growth in our program and anticipate testing the method on larger classes in the near future.

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